Concept of Use for Multiple Convective Products

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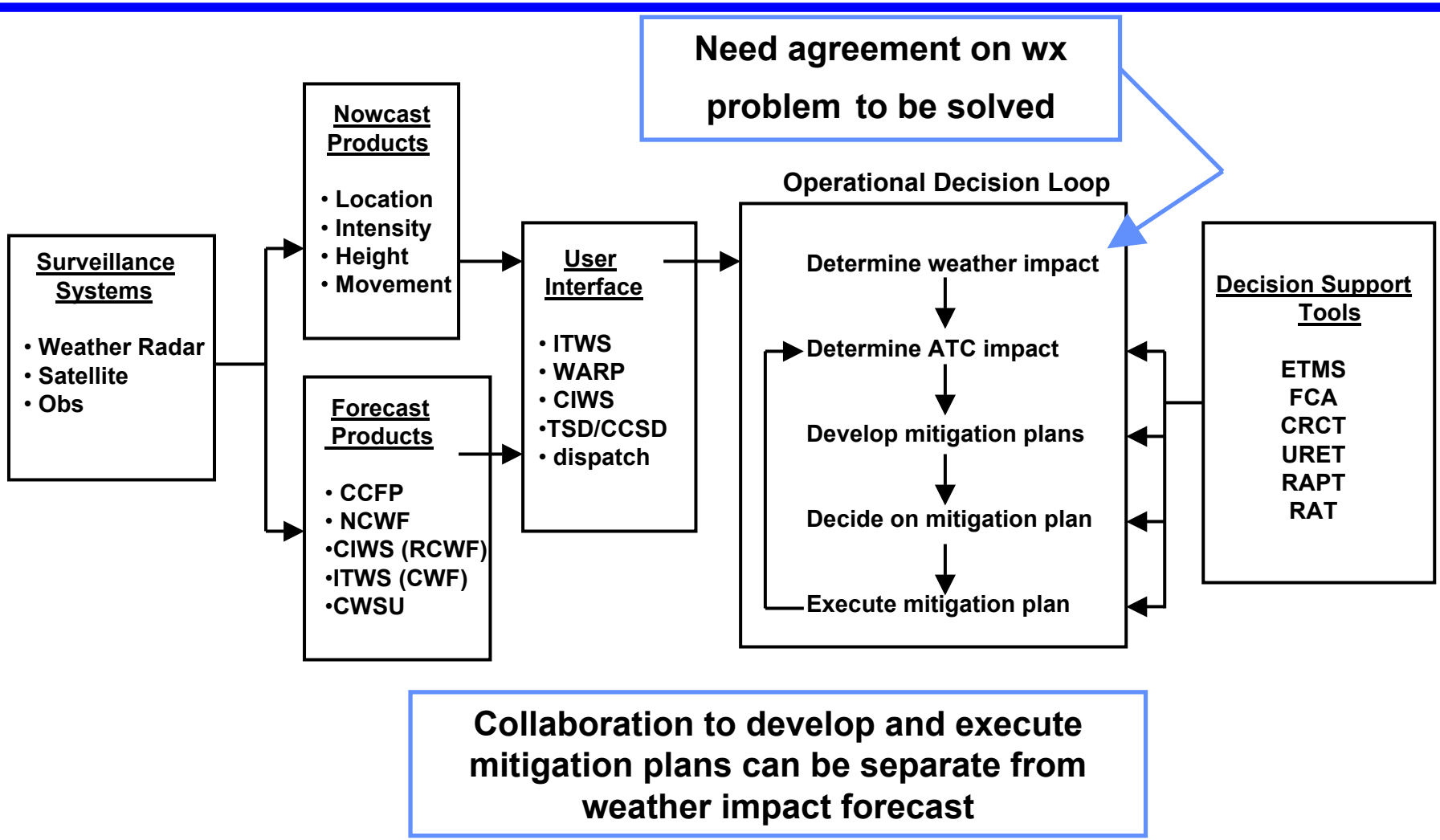
- Why an issue? Multiple products now exist to support decisions such as
  - "wait-n-see" vs invoke use of playbook routes
  - "Pivot points" on Playbook routes
  - What to use in creating an FCA
- Capabilities of forecasts available May 2003
- Performance of CCFP
- Suggestions

TFM/CR and Convective Wx Products

- Traffic flow management (TFM)/collaboration is essential when airspace congestion is such that demand > capacity
- Execution of TFM/CR plans is fundamentally forecasting of
  - future demand
  - future capacity
- Severe convective weather significantly reduces capacity/route availability – we must anticipate where and when the capacity reductions will occur
- All of the forecasts available today have inaccuracies – we need to use them in a "sensible" way:
  - Well known theory (e.g., as in flight guidance systems) suggests weighting forecasts based on expected accuracy for the location and time of concern

Weather Impact Mitigation Paradigm



Success= executed the right mitigation plan

Current Forecast Capabilities

Forecast			Forecast Time (hrs)					
	6		4		2	1	0.5	0
CCFP	x		x		x			
NCWF						x		
CIWS					x	x	x	x
ITWS							x	x
adv ITWS						x	x	x

Coverage:

- CCFP, NCWF – national
- CIWS – Great Lakes, Northeast corridors
- ITWS-100 nmi of MCI, HOU, MIA, ATL, MEM, DFW, MCO, NY

- **Growth/decay of storms: CCFP, CIWS**
- **Update rate for forecasts:**
  - CCFP – 2 hours
  - NCWF, CIWS, ITWS, advanced ITWS – 5-15 mins
- **Real time forecast accuracy metrics**
  - CIWS, advanced ITWS
  - NCWF only when viewed on AWC site

CCFP Performance

- CCFP major benefit is forecast of severe wx coverage
- Statistics (see Appendix) show that nearly all CCFPs issued fall into three combinations of coverage and "confidence"

Issued forecast ← Actual coverage →

Coverage	Confidence	How frequently issued	2-hr Forecast	4-hr forecast	6-hr forecast
Low	Low	53% of all CCFPs	< 25 % over 50% of time	< 25 % over 60% of time	< 25 % over 60% of time
Low	Med	39 % of all CCFPs	= forecast coverage 50% of time	= forecast coverage ~50% of time	< forecast coverage over 50% of time
Med	Med	6 % of all CCFPs	= forecast coverage 50% of time	Generally = "low" coverage	Generally = "low" coverage

Operational Decisions Using CCFP

TFM/CR Decisions of concern

- Use of "wait-n-see"
- "Pivot points" on playbook routes
- What to use in creating an FCA

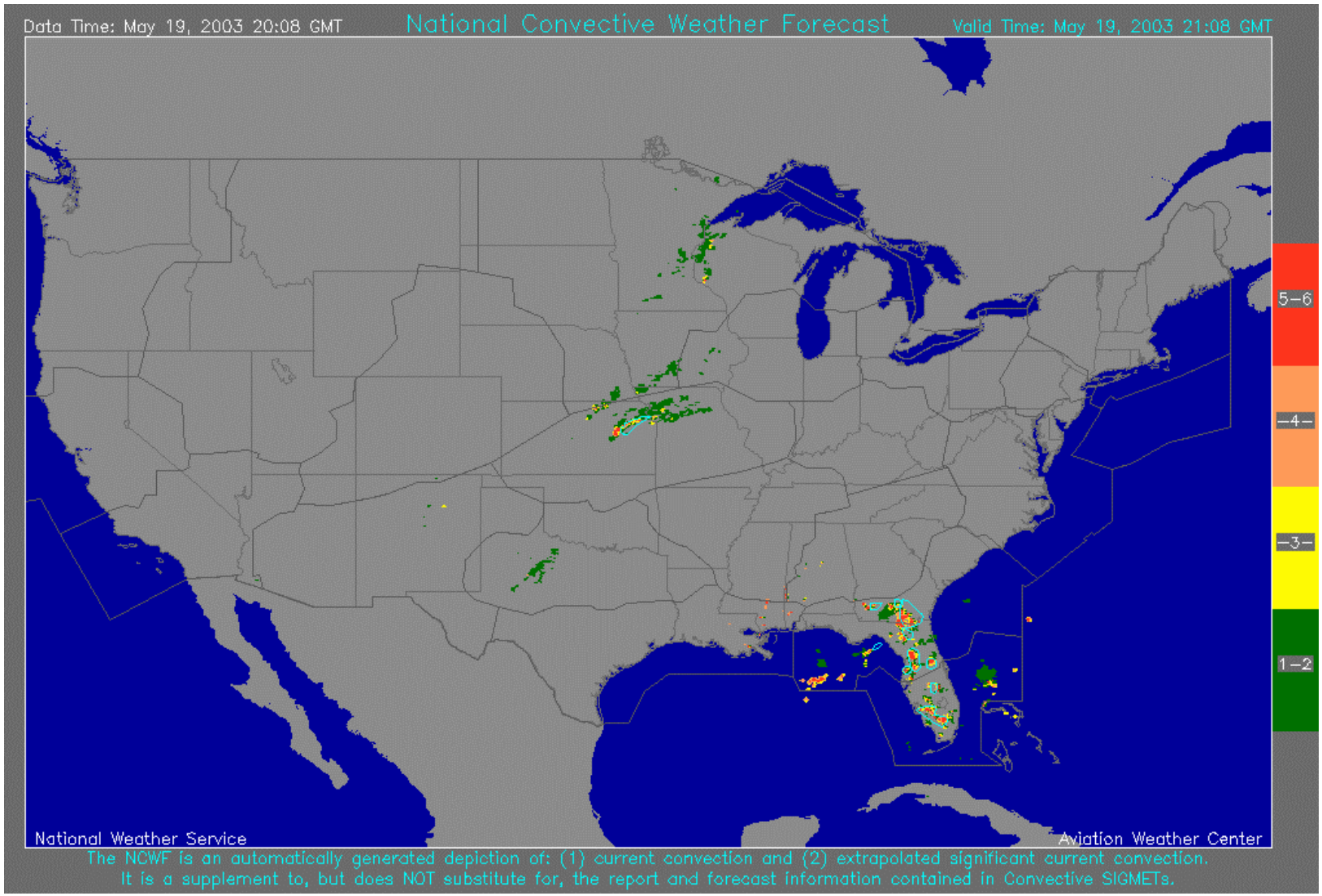
Conclusions

- For forecast times of 4 or 6 hours, CCFP is "only ball game"
  - Consider "wait-n-see" with low coverage/low confidence CCFP
  - Other CCFPs generally yield "low" coverage wx
- At 2 hours, actual and CCFP coverage "agree" for "medium" confidence forecasts
  - Operational problem is translating CCFP "coverage" to estimates of route availability and/or sector capacity
  - Consider alternative forecasts that are now available

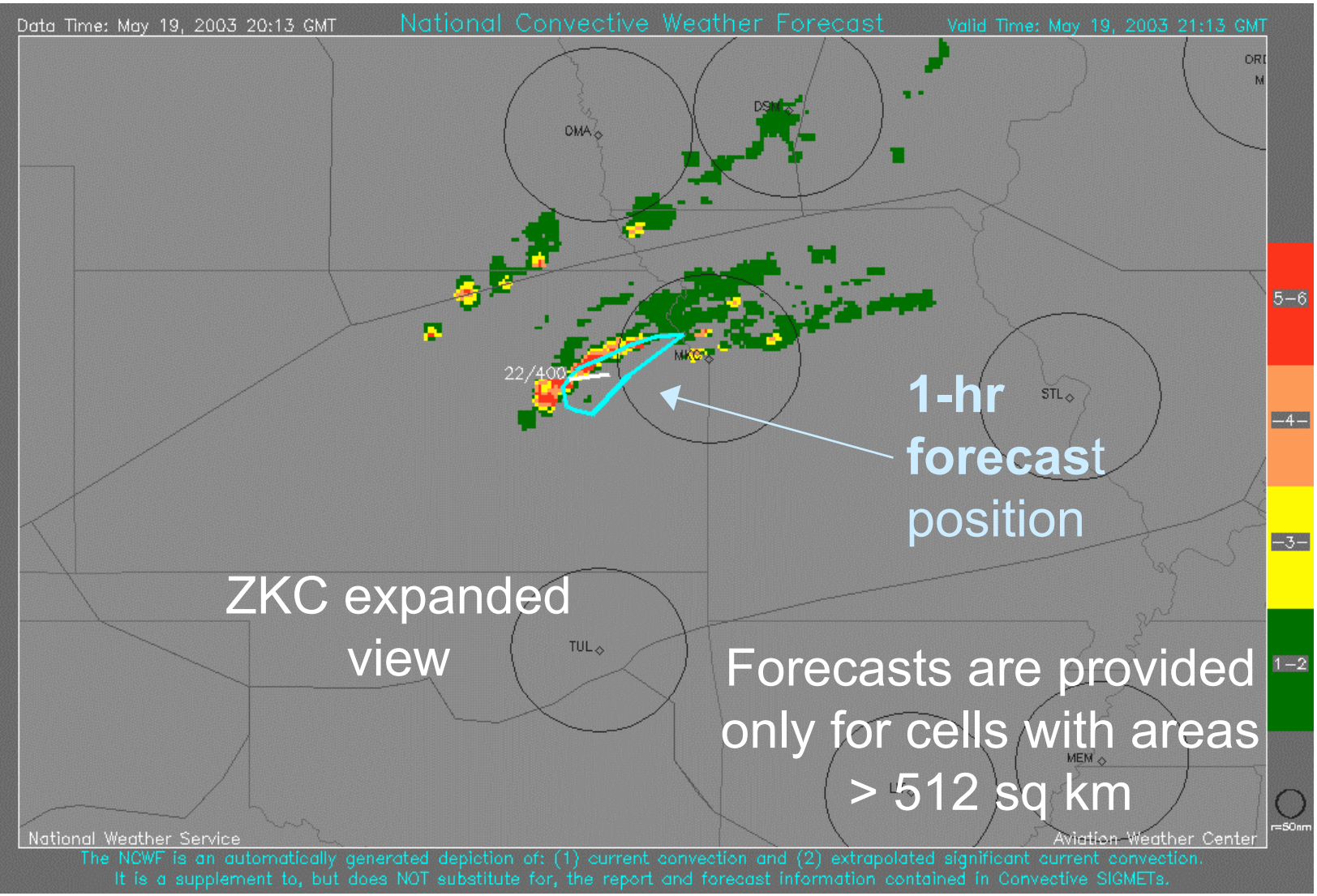
    CIWS where available

    NCWF otherwise

National Convective Weather Forecast (NCWF)

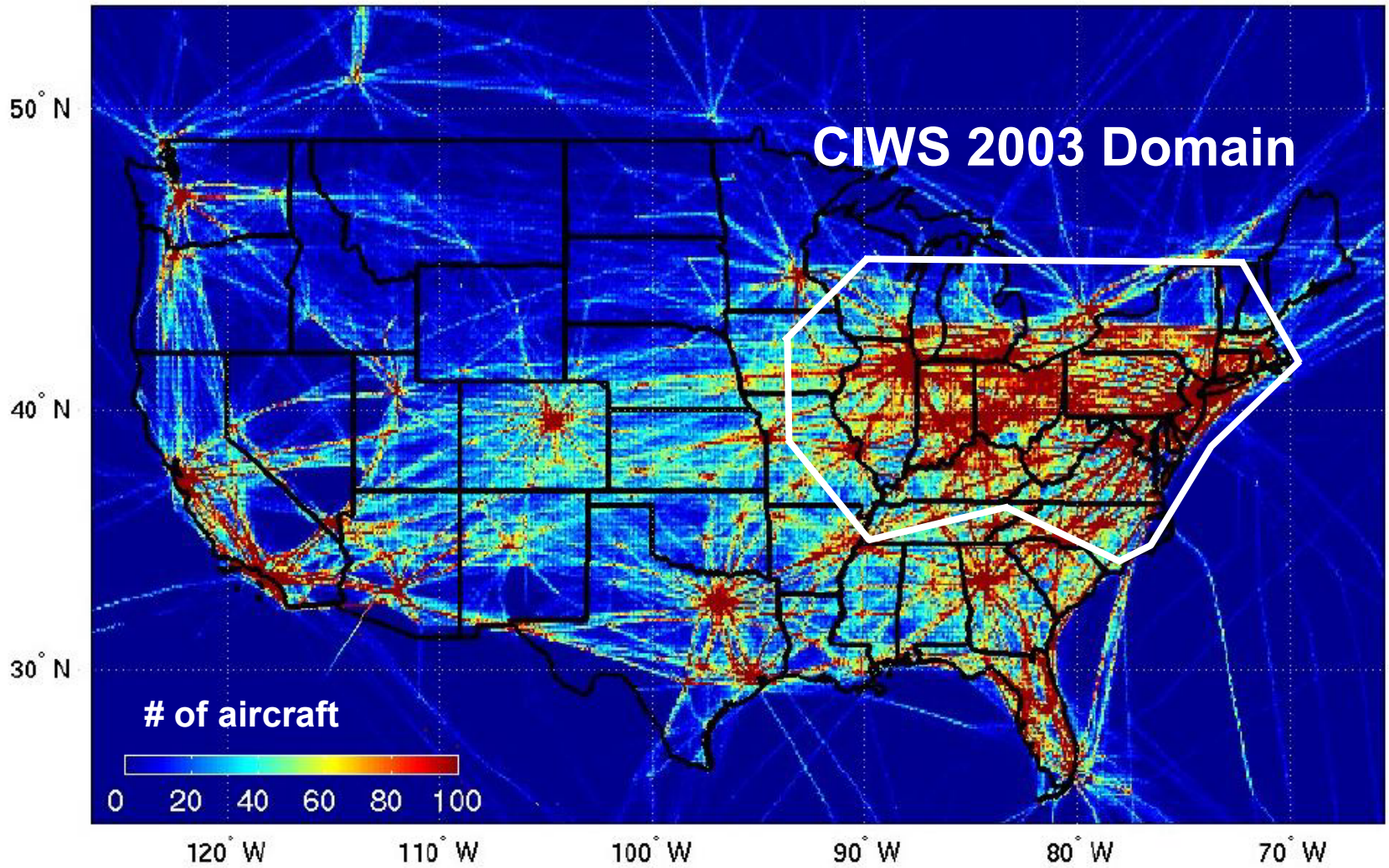


National Convective Weather Forecast (NCWF)

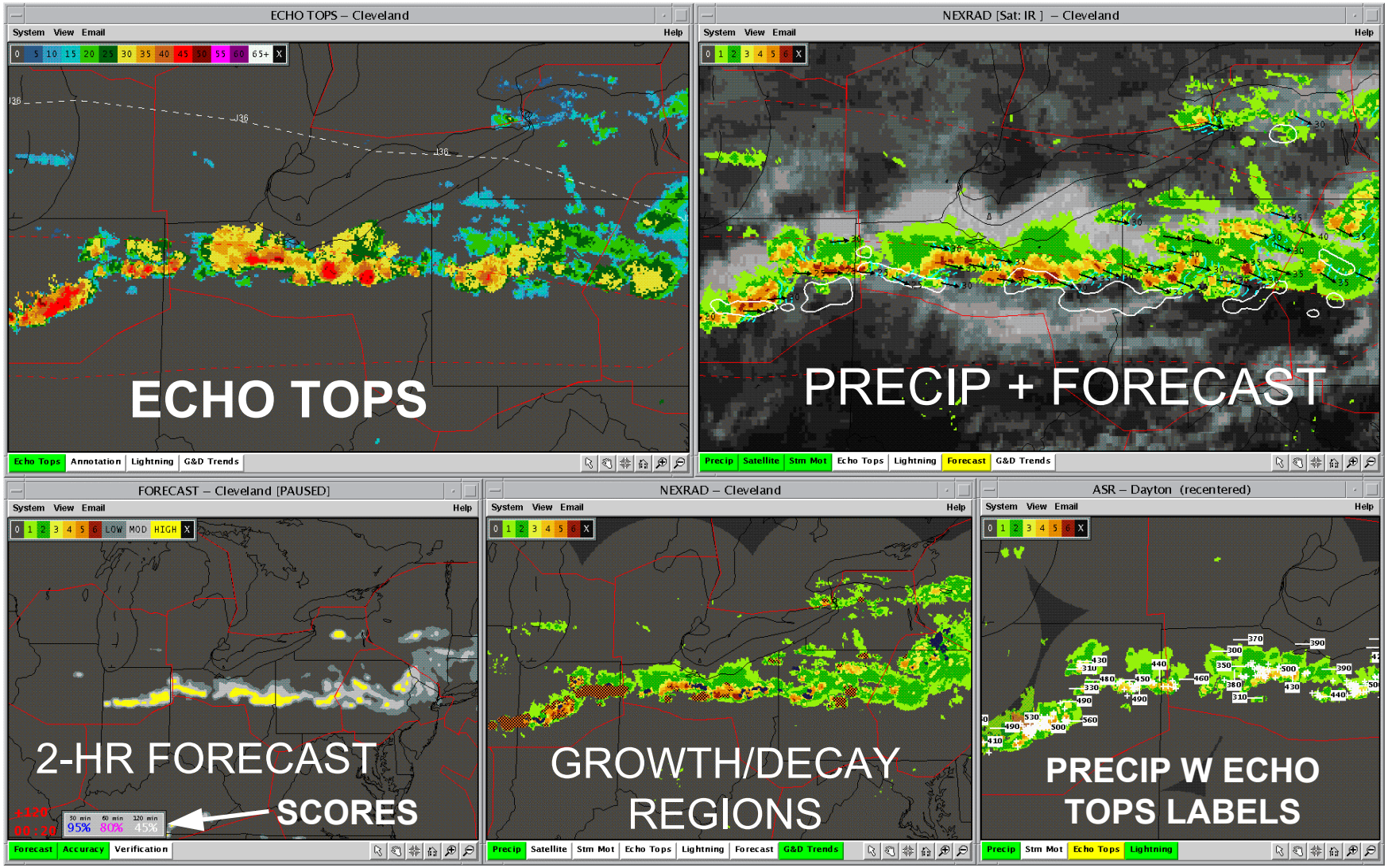


CIWS Availability May 2003

Air Traffic 09/12/02 1000 UTC – 09/13/02 1000 UTC

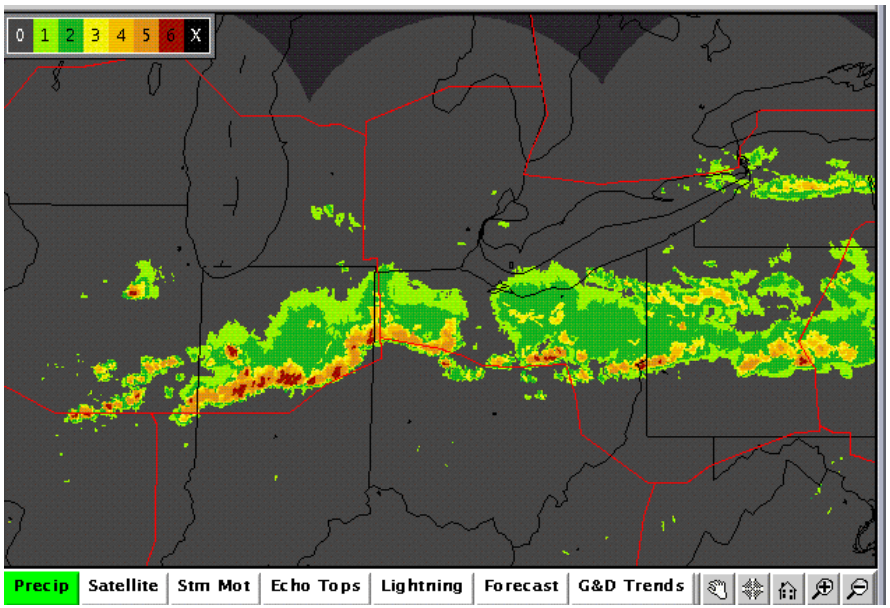


CIWS Display

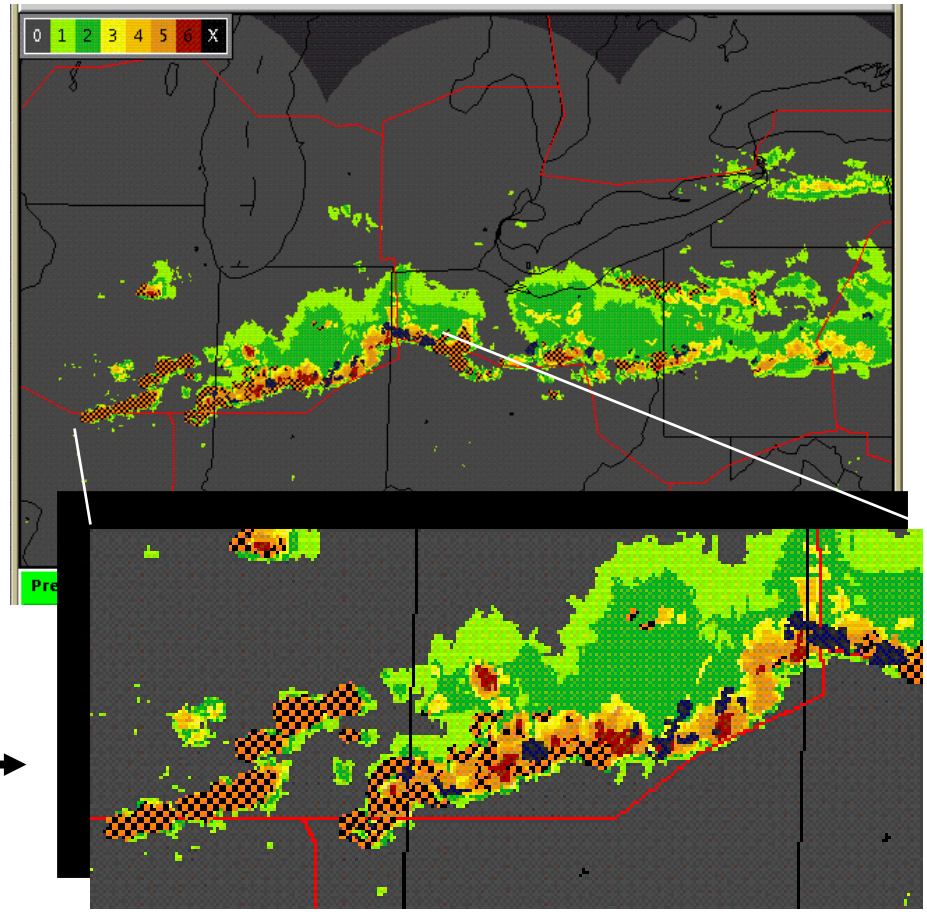


CIWS Growth & Decay Trends Display

Precip with no contour

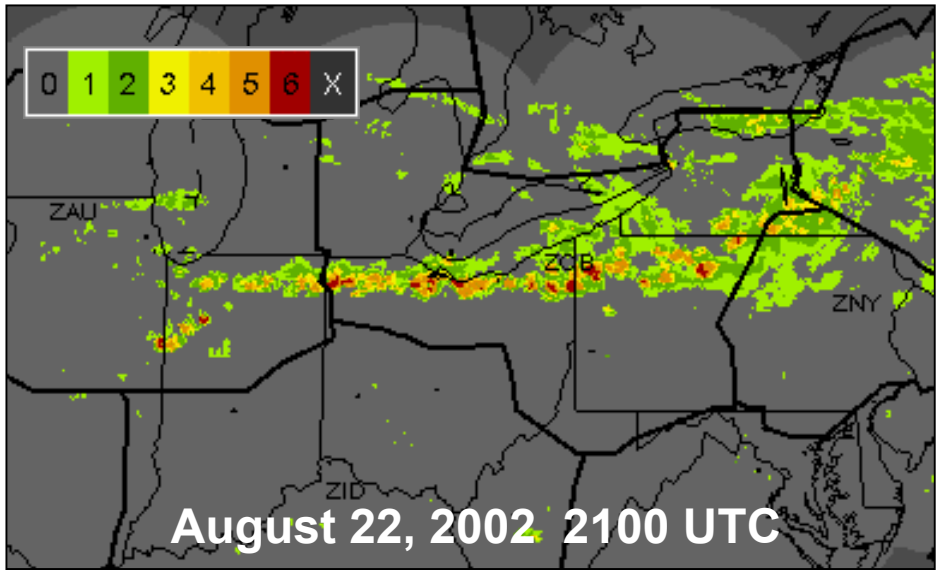


Precip with G&D Trends overlay



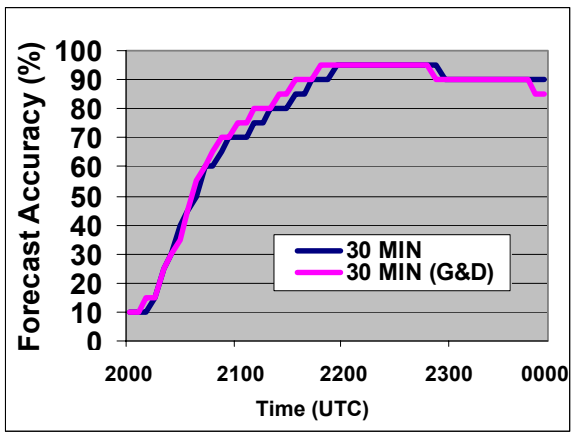
Close up of Trends overlay →

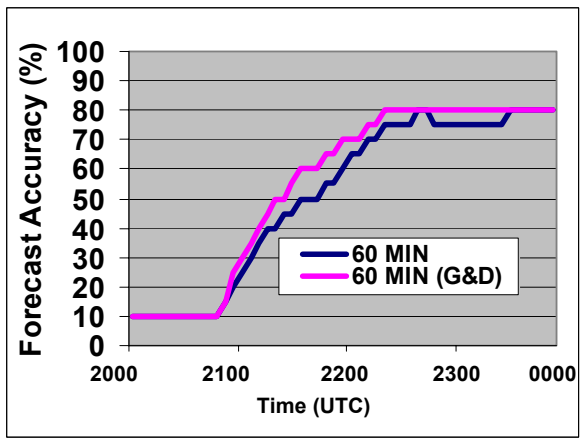
Performance of 2002 vs. 2003 CIWS Forecast

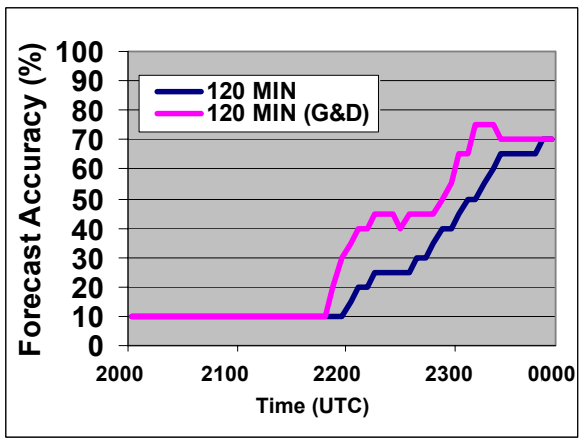


CIWS Forecast Accuracy Scoring Trends

Detroit





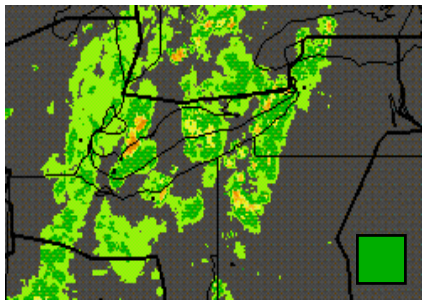


Estimating Route Availability & Capacity

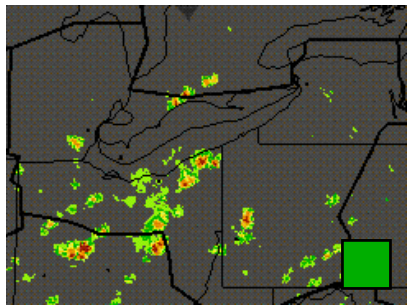
- A critical issue for TFM/CR is translating the convective weather forecast into forecasts of route availability and sector/terminal capacity
  - CCFP forecasts provide no insight into the type of weather that will occur which is a key factor
  - CIWS forecasts suggest the type of convective weather that will occur as well as showing the density of significant precipitation
- Following slides show:
  - Type of convective weather that typically occurs
  - CCFP forecasts and actual weather for a number of different types of convective weather
- Operational decision makers can decide which type of forecast provides better insights into route availability and sector/terminal capacity

CIWS Storm Events in 2002

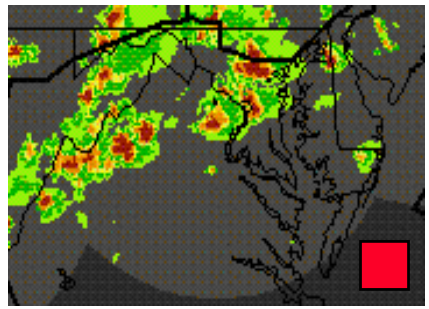
Embedded



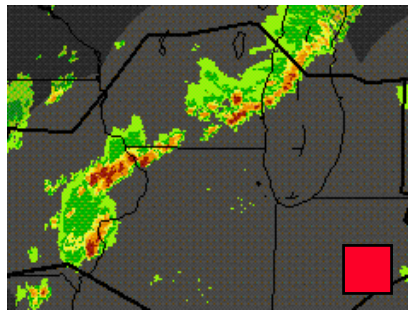
Unorganized Cellular

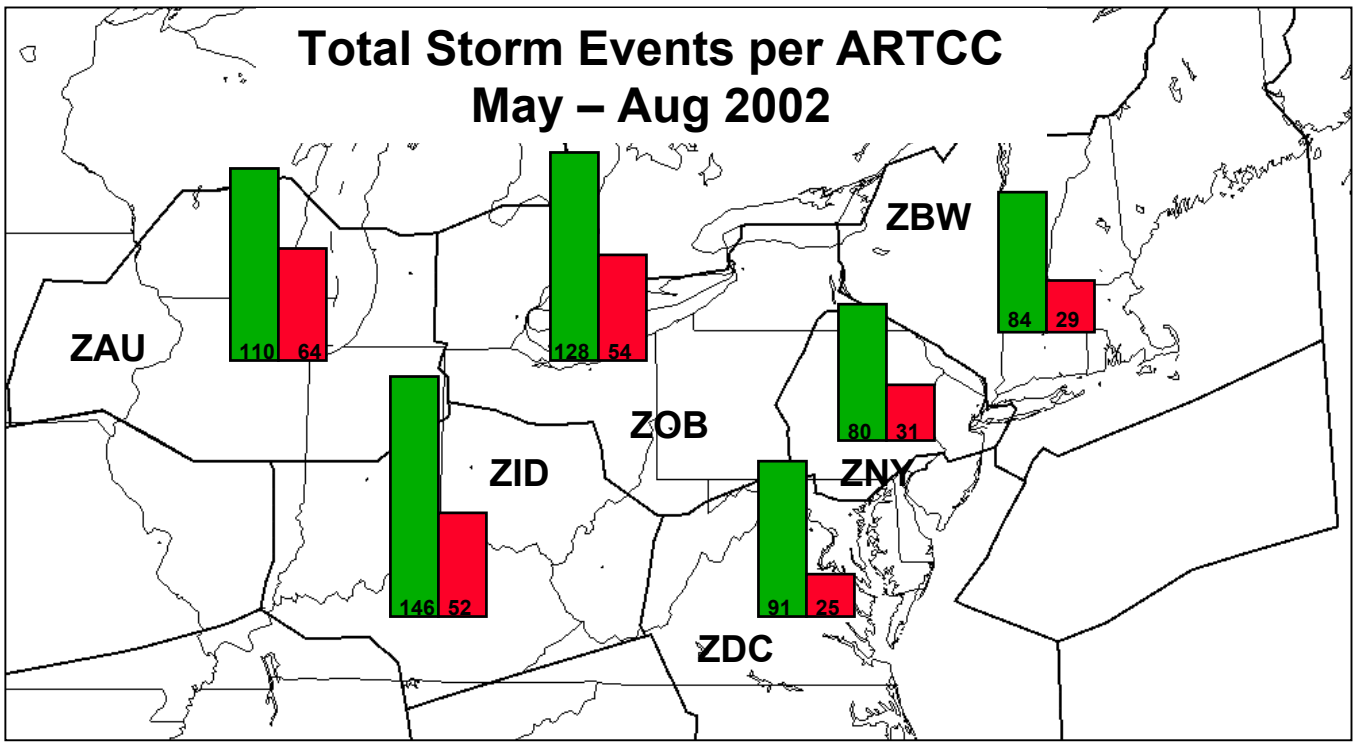


Convective Complex



Linearly Organized





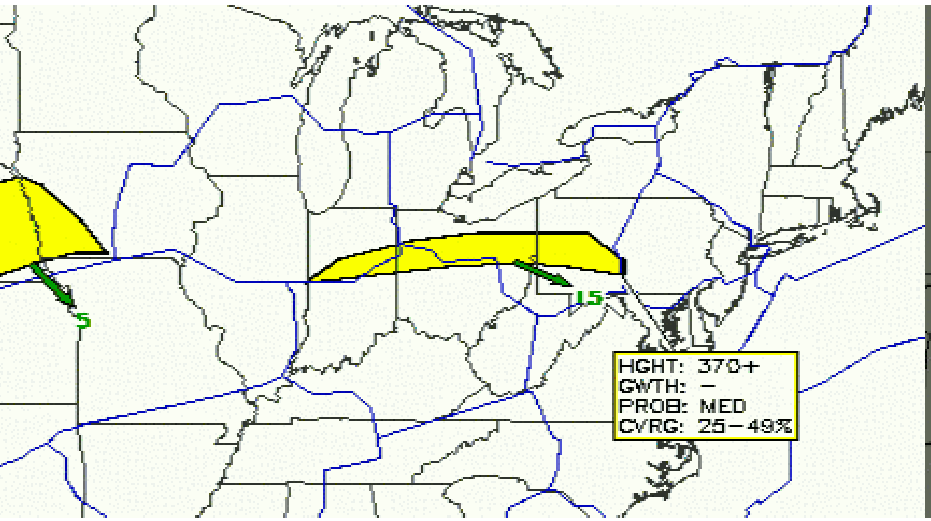
Unorganized Convective Events

Organized Convective Events

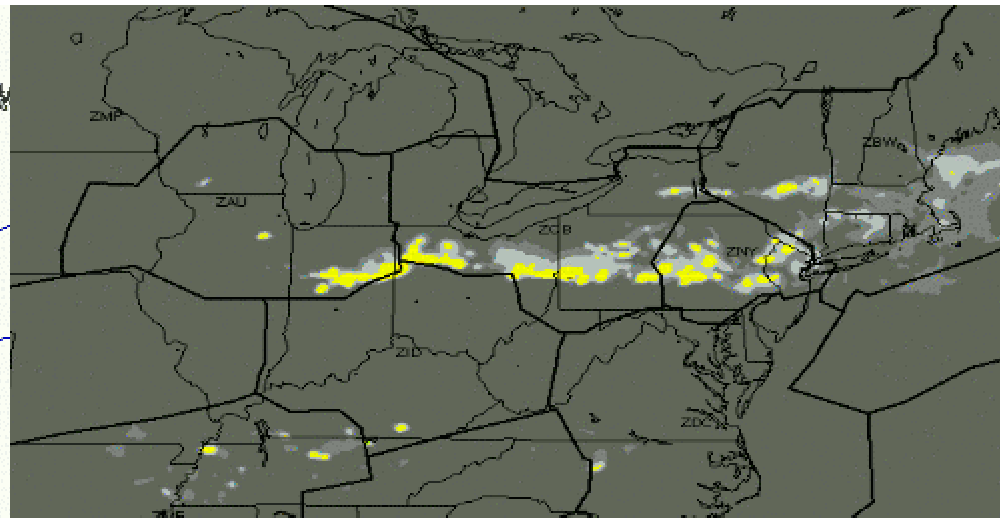
Utility of various forecasts depends on type of convective weather

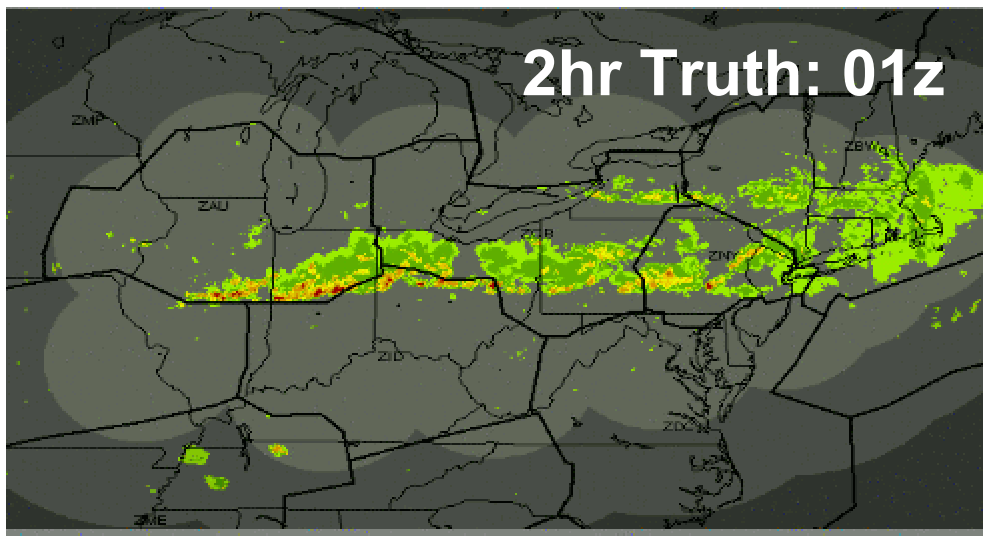
CCFP vs. RCWF - Line Storm Example

2hr CCFP:23z



2hr RCWF: 23z

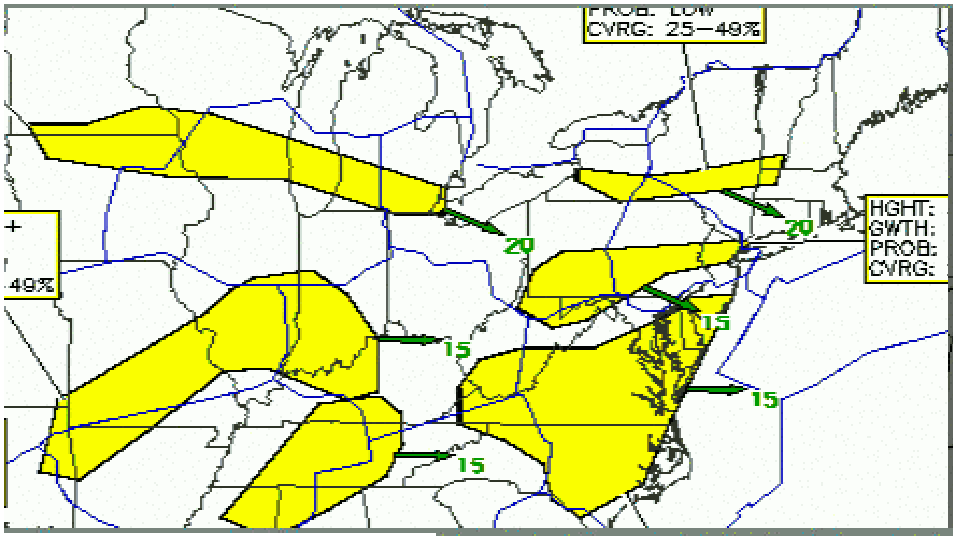




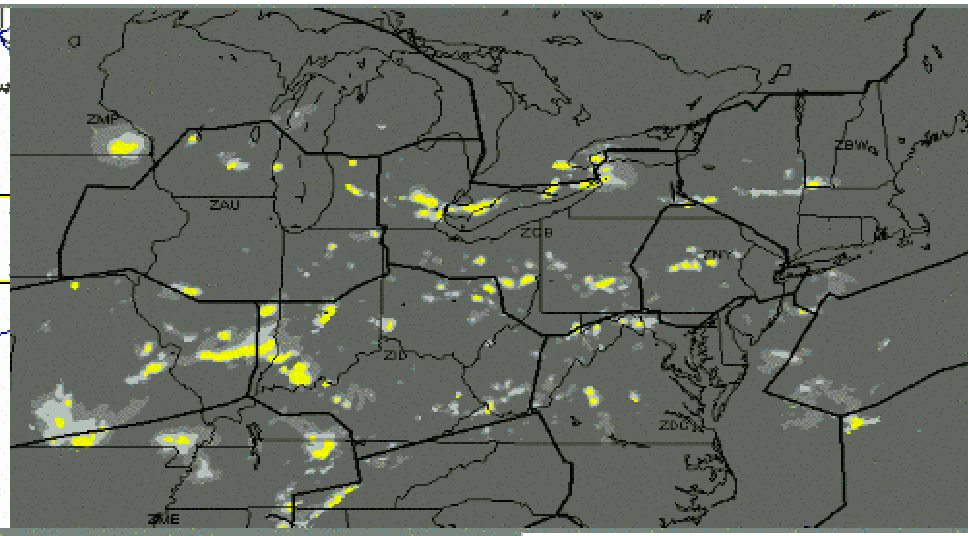
22nd August 2002

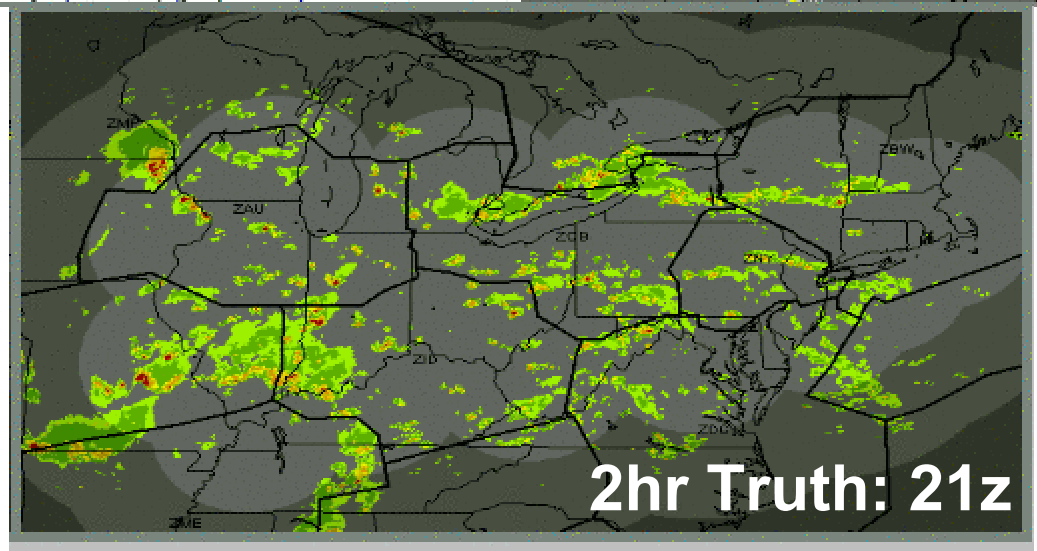
CCFP vs. RCWF - Airmass Example

2hr CCFP: 19z



2hr RCWF: 19z

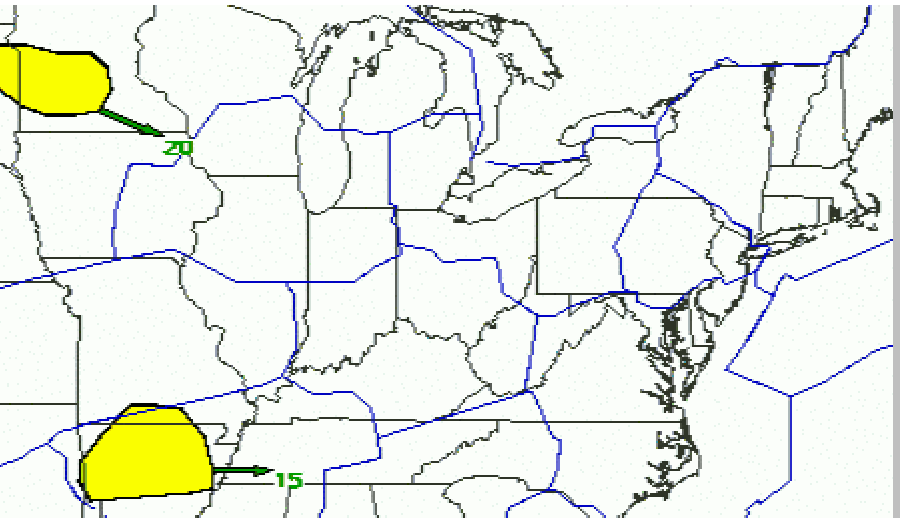




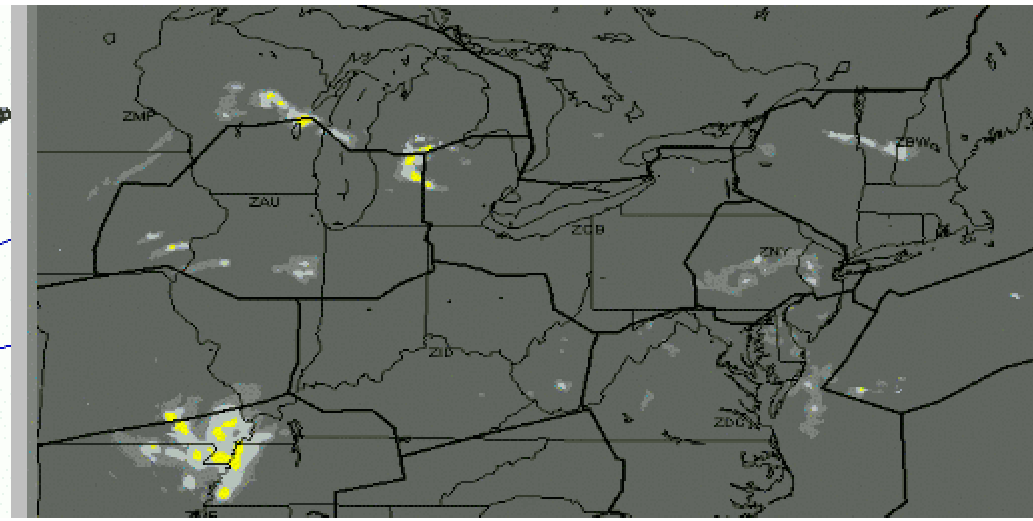
18th July 2002

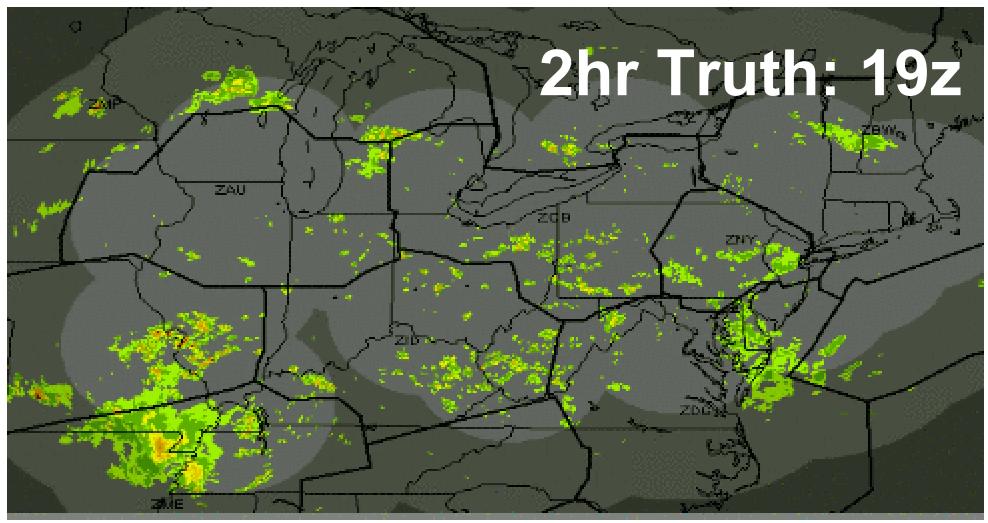
CCFP vs. RCWF - Airmass Example

2hr CCFP: 17z



2hr RCWF: 17z

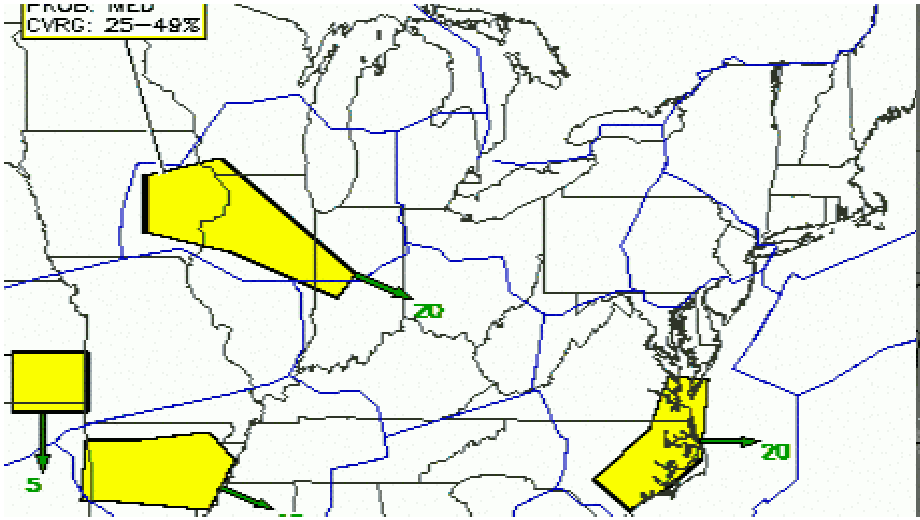




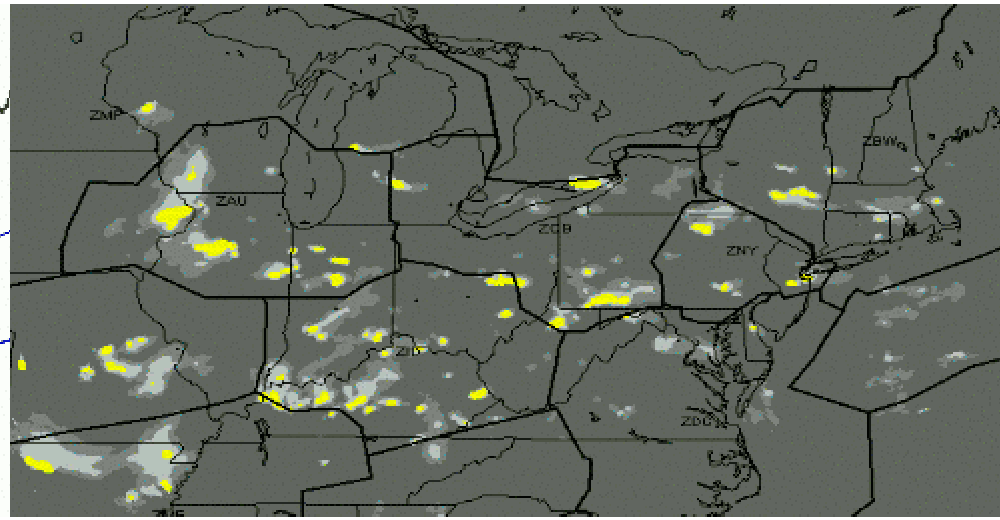
18th July 2002

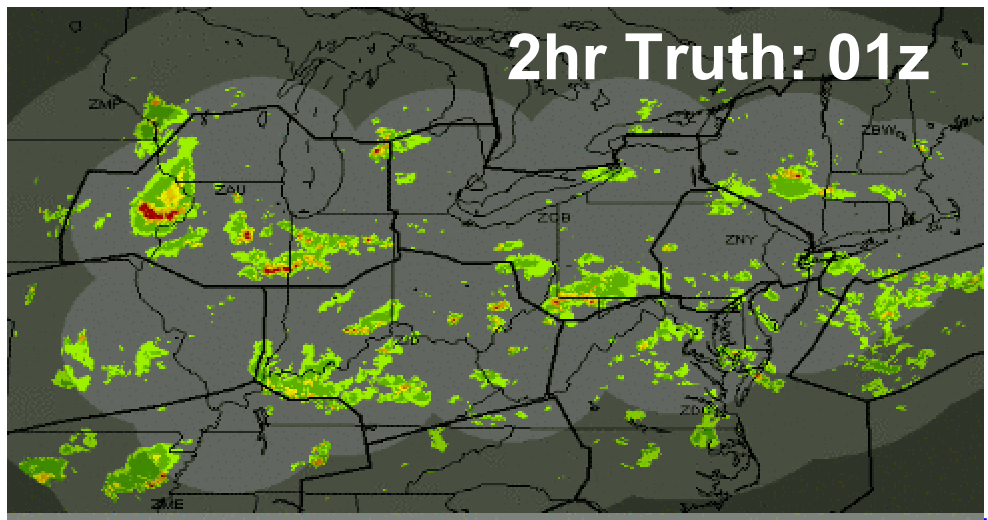
CCFP vs. RCWF - Airmass Example

2hr CCFP: 23z



2hr RCWF: 23z





18th July 2002

Summary

- Recommend regional decisions on “best” forecast to use for key collaborative decisions such as:
  - Use of “wait-n-see” versus use of a “playbook”
  - “Pivot points” on Playbook routes
  - What to use in creating an FCA
- CCFP is clearly basis for 4- and 6-hour lead time – statistics have been presented that suggest when to opt for “wait-n-see”
- At 2-hour lead time, consider regional use of CIWS unless CCFP forecast parameters suggest higher accuracy
- For 1-hour lead time decisions
  - Use CIWS where available
  - NCWF otherwise unless advanced ITWS forecast is available

Appendix

- The following slides show the statistical distribution of actual weather coverage as a function of the forecast:
  - Lead time (2-, 4- and 6-hours)
  - Forecast coverage
  - Forecast "probability" or "confidence"
- The "box plots" in slides 2-4 after this slide have the following explanation:
  - The upper and lower ends of the "box" represent the upper and lower quartiles; the middle of the "box" is the median. The * is the mean
  - Extremes are shown as the points at the upper and lower ends of the lines from the "boxes".

(Murphy and Katz, Probability, Statistics and Decision Making in the Atmospheric Sciences, Westview Press, 1985, pages 1-43 discuss "box plots")

Frequency of Various CCFPs

Predicted coverage

2001	"low" 25-49%	"med" 50-74%	"high" 75-100%
"low" 1-30%	51%	1 %	
"med" 30-74%	40%	6 %	
"high" 75-100%	1 %	1 %	

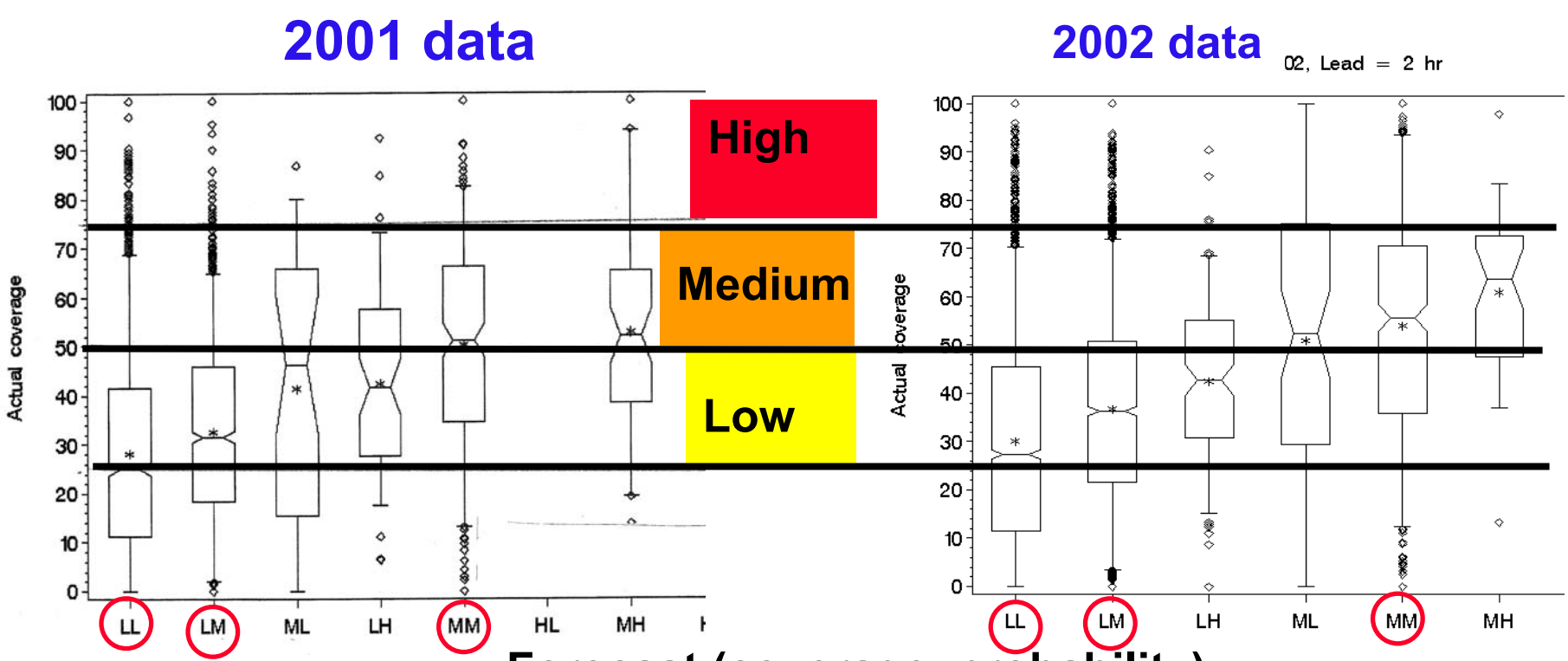
"probability"

Predicted coverage

2002	"low" 25-49%	"med" 50-74%	"high" 75-100%
"low" 1-30%	56 %	1 %	
"med" 30-74%	38 %	5 %	
"high" 75-100%	1 %		

From: Mahoney, J., B. Brown, J. Hart, J. Henderson, 2003: Objective verification results for CCFP 2002. Report to be submitted to CDM/CR working group and ATCSCC

Actual Wx Coverage vs 2-hr Forecast of Coverage and Probability

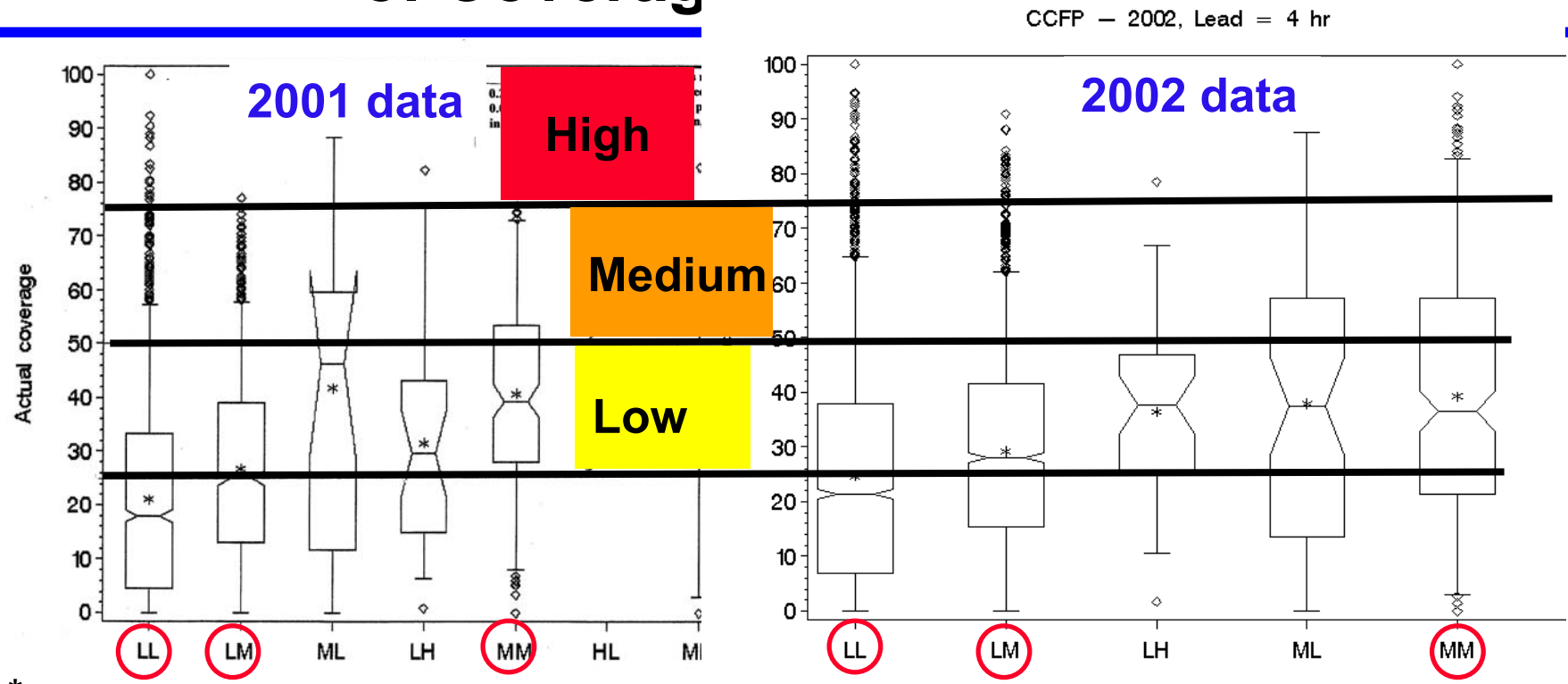


* = average coverage

Actual coverage was closer to forecast coverage for "medium" coverage forecasts in 2002; actual coverage was slightly closer to forecast coverage for "low" coverage forecasts in 2002

From: Mahoney, J., B. Brown, J. Hart, J. Henderson, 2003: Objective verification results for CCFP 2002. Report to be submitted to CDM/CR working group and ATCSCC

Actual Wx Coverage vs 4-hr Forecast of Coverage and Probability



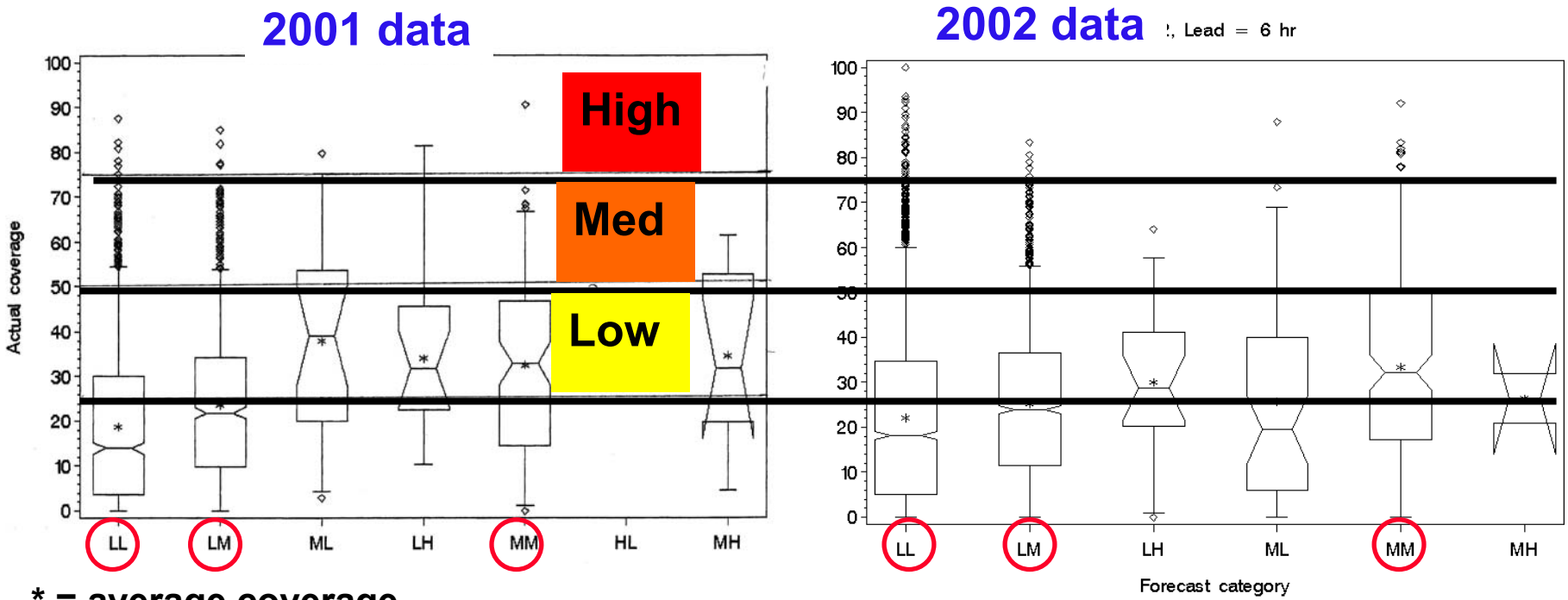
* = average coverage

Forecast (coverage, probability)

Actual coverage was a bit closer to forecast coverage for "low" coverage forecasts in 2002; accuracy of "medium" coverage forecasts was unchanged

From: Mahoney, J., B. Brown, J. Hart, J. Henderson, 2003: Objective verification results for CCFP 2002. Report to be submitted to CDM/CR working group and ATCSCC

Actual Wx Coverage vs 6-hr Forecast of Coverage and Probability



* = average coverage

Forecast (coverage,confidence)

Actual coverage was a bit closer to forecast coverage for "low" and "medium coverage" forecasts in 2002; "low" coverage generally results when "medium" coverage is forecast

From: Mahoney, J., B. Brown, J. Hart, J. Henderson, 2003: Objective verification results for CCFP 2002. Report to be submitted to CDM/CR working group and ATCSCC

CCFP 2-Hr Performance 6-12 May 2003

Forecast		# forecasts	Actual	Coverage	
Coverage	Confidence		< forecast ("over warned")	= forecast	> Forecast ("under forecast)
Low	Low	51 (45%)	59 %	37%	4%
Low	Medium	44 (39%)	7 %	82%	11%
Medium	Medium	18 (16 %)	17%	56%	28%